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(54) AQUARIUM LIGHTING SYSTEM AND METHOD

AQUARIUMBELEUCHTUNGSSYSTEM UND -VERFAHREN

SYSTÈME ET PROCÉDÉ D'ÉCLAIRAGE D'AQUARIUM

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Description

FIELD OF THE INVENTION

[0001] This invention relates to lighting arrangements for aquarium lighting.

BACKGROUND OF THE INVENTION

[0002] When directional light enters a water surface, so-called caustic patterns are projected on the bottom. Such projected patterns occur when the light is highly collimated (such as light from the sun or a from a narrow beam light source) or when the source is very small such as an LED. Large diffuse sources, like conventional tungsten tubes, or indirect lighting, do not produce caustics.

[0003] In aquarium lighting, LEDs have the advantage of high efficacy and easy spectral tunability. However, the resulting array of point-like sources may result in a restlessly moving caustic pattern in and around the aquarium, as well as colour patterns and coloured shadows.

[0004] While the caustic patterns to some extent may be appreciated inside the aquarium (since it is caused by the water dynamics), part of the light may also leak out of the aquarium and create a restless pattern on the floor in the vicinity of the aquarium. This may be found to be a disturbing effect. It occurs when light enters the water at a steep angle to the vertical normal (in fact above 63 degrees to the vertical). This effect is illustrated in Figure 1, in which beam 10 has a steep angle to the vertical above 63 degrees, whereas beam 12 has a shallower angle below 63 degrees.

[0005] Water has a relatively low refractive index (typically $n=1.34$), and this means that light at these high incident angles is not reflected by total internal reflection at the side wall, but it can refract out of the water volume and land on the floor. This light which has leaked from the sides of the aquarium may then project restless caustic patterns onto the floor.

[0006] Light 12 at smaller angles stays within the aquarium by total internal reflection at the sides of the aquarium.

[0007] A solution to keep all light within the water volume is to limit the light to beam angles well within 63 degrees to the vertical direction, for example by placing a collimator on each LED. While this directional lighting is more efficient since more light stays inside the aquarium, it also has some drawbacks. Directional lighting, in particular with hard cut off angles, produces so-called scalloping on the back side of the aquarium, which is visible as alternating bright and dark areas, as well poor illumination of the objects in the aquarium. In particular, a high contrast between the top and bottom parts of an object can result, with loss of visible shape details. Furthermore, homogenous lighting is recognized as benefiting coral growth, such as the speed of growth. Directional light from above may for example result in bleach-

ing of the bottom parts of the coral, which is visible when viewing the aquarium from the front.

[0008] US 8 646 934 discloses an aquarium lighting system in which lenses are used to define precise angular outputs from lighting elements. US 2012/326610 A1 discloses a lighting unit for illuminating a habitat. The lighting unit includes a housing and a light emitter. The light emitter comprises (i) a printed circuit board with individual light emitters and (ii) a reflector including individual light guides wherein each individual light guide surrounds a corresponding light emitter. The use of the individual light guides lowers the level at which light from individual light emitters crosses one another, allowing for a more even distribution of light

[0009] There is therefore a need for an aquarium lighting solution which is efficient and versatile, for example enabling implementation using LEDs, and which gives a minimum of disturbing caustic patterns on the floor, as well as controlling the caustic pattern (e.g. the frequency) in the aquarium. Scalloping or harsh shadows should also be avoided in the aquarium.

SUMMARY OF THE INVENTION

[0010] The invention is defined by the claims, and provides in particular an aquarium lighting system according to independent claim 1.

[0011] The aquarium lighting system comprises:

- a base layer;
- a set of lighting elements mounted on the base layer;
- a beam shaping element associated with each lighting element, wherein the beam shaping element is for passing first light which is emitted from the lighting element at an angle to the normal below a threshold and for processing second light which is emitted from the lighting element at an angle to the normal above the threshold, the processing resulting in a greater amount of scattering compared to the passed first light.

[0012] The beam shaping element is an optical element which may for example surround or partially surround each lighting element, which may be an LED or a cluster of LEDs that are closely spaced together. Thus, one beam shaping element may be associated with multiple lighting elements. Each lighting element is associated with a beam shaping element, but not necessary a beam shaping element which is unique to that lighting element.

[0013] The beam shaping element blocks the direct view to the lighting element at angles above the threshold, which thus functions as a cut off angle. The light which is received beyond the cut off angle is processed, for example redistributed by a light scattering element. Thus, most of the light with angles smaller than the cut off angle is allowed to pass without scattering, or with much less scattering than the steeper processed light.

[0014] The beam processing comprises a scattering function. Thus, if a reflecting surface is used for the scattering, it is preferably a diffuse reflector rather than a specular reflector. In this way, the angular spread of the output light is not limited to a particular cut off angle, but there is a cut off angle for direct light (i.e. which undergoes no reflections between the lighting element and the water).

[0015] The projection of caustic patterns on the floor may in this way be reduced or completely removed by blocking the direct light at high angles. However, light at high angles is desirable to avoid scalloping and poor object lighting, so this light is not entirely blocked but rather it is processed to increase the degree of scattering, thereby retaining a larger virtual light source. The light at large angles to the normal will in this way come from a large virtual source, and create blurry projections that are less noticeable than sharp caustic patterns. The direct lighting originates from a real point source. In this way, the optical function is not simply a beam limiting function, but it provides different beam processing for shallow angles compared to wide angles.

[0016] The scattering of the light at high angles will also result in some of the scattered light being redirected to overlap with the direct (less scattered) light. In this way, the caustic effect inside the aquarium is also reduced. In particular, there caustic effect is also more diffuse. The processing of second light thus eliminates or substantially eliminates the caustic effect outside the aquarium and also reduces the caustic effect inside the aquarium.

[0017] To reduce the caustic effect further inside the aquarium, the function of passing the first light may also include a diffusion (scattering) function, but with reduced scattering compared to the processing of the second light.

[0018] The base layer may for example comprise a printed circuit board. The lighting elements may comprise LEDs, for example formed as an array on the printed circuit board.

[0019] The threshold is preferably in the range 45 to 63 degrees, for example in the range 55 to 63 degrees, and for example in the range 55 to 60 degrees. In this way, direct light can be prevented which would escape through the side walls of the aquarium.

[0020] In one example which does not form part of the invention, the beam shaping element comprises a scattering reflector having a scattering and reflecting side wall at opposite sides of the lighting element or surrounding the lighting element. This side wall may surround the lighting element or it may be on opposite lateral sides, depending on the lighting element design. The side wall defines an aperture which then forms the cut off angle. However, the cut off light is also projected, after reflecting on the scattering surface.

[0021] The scattering reflector may have a tapered side wall which widens outwardly with increasing distance from the lighting element. Alternatively, the scat-

tering reflector may have a stepped side wall.

[0022] According to the invention, in a first alternative, the beam shaping element comprises a plate having a patterned diffuser, with an opening in the diffuser pattern for passing the first light. The opening defines the cut off angle, and light provided to the opening is passed without diffusion.

[0023] According to the invention, in a second alternative, the beam shaping element comprises a patterned light guide having an opening in the light guide for passing the first light. Light with a steeper angle than the threshold passes into the light guide at a side face of the light guide and is then reemitted from the light guide by a scattering element or surface. The second light may for example be reemitted with an essentially random location and direction.

[0024] The first light may be passed with no optical processing at all. However, the beam shaping element may instead comprise a scattering element for scattering said first light, with a smaller amount of scattering than the processing of the second light. The (reduced amount of) scattering of the first light reduces the effect of caustic patterns inside the aquarium.

[0025] The invention also provides an aquarium according to independent claim 8, said aquarium comprising a water container and a lighting system as defined above. The lighting system may project light centred in a vertically downward direction to the water below. The lighting system may be distributed over an area which is similar to the area of the water container to provide illumination to the full water volume of the aquarium. In use, the lighting system may for example be positioned 10 to 25 cm above the water surface.

[0026] The invention also provides a method of lighting an aquarium according to independent claim 10, said method comprising:

providing a light output from a set of lighting elements mounted above the water of the aquarium;

passing first light which is emitted from the lighting elements at an angle to the normal below a threshold; and

processing second light which is emitted from the lighting elements at an angle to the normal above the threshold by means of a plate or a patterned light guide as mentioned above, the processing resulting in a greater amount of scattering compared to the passed first light.

[0027] The threshold is for example in the range 45 to 63 degrees, more preferably in the range 55 to 63 degrees, even more preferably in the range 55 to 60 degrees.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] Examples will now be described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows how light of certain angles can escape through the side wall of an aquarium;

Figure 2 shows an aquarium with a lighting system;

Fig. 3 shows a lighting element with no beam shaping at the output;

Fig. 4 shows a first example of beam shaping system;

Fig. 5 shows a second example of beam shaping system;

Fig. 6 shows a third example of beam shaping system, according to the first alternative of the invention;

Fig. 7 shows a fourth example of beam shaping system, according to the second alternative of the invention;

Fig. 8 shows a first example of lighting system; and

Fig. 9 shows a second example of lighting system.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0029] The disclosure provides an aquarium lighting system which has a set of lighting elements each associated with a beam shaping element for passing first light which is emitted from the lighting element at an angle to the normal below a threshold. The beam shaping element processes second light which is emitted from the lighting element at an angle to the normal above the threshold. The processing gives a greater amount of scattering compared to the passed light so that direct light at steep angles is avoided.

[0030] Figure 2 shows an aquarium which comprises a water vessel 20 having a lighting system 22 suspended over the water. The lighting system projects light essentially downwardly to the water below. The lighting system is sized to provide illumination to the full water volume of the aquarium. The lighting system may for example be positioned 10 to 30 cm above the water surface.

[0031] Light which is directed downwardly near to the vertical (shown as solid lines) is provided without any significant beam shaping or scattering. The lighting system preferably comprises an array of LEDs, and the light at these shallow angles to the vertical appears as an array of point light sources. The light is trapped by total internal reflection at the side walls of the aquarium, and it may create a caustic pattern at the base of the aquarium. Light which is directed downwardly far from the vertical (shown as dashed lines) is subjected to scattering. The light at these steeper angles to the vertical appears to have originated from a large area source as a result of the scattering. Light which remains, after the scattering, at a steep angle may escape through the side walls of the aquarium, but the caustic light pattern effect is reduced for this light. By allowing light at the steep angles (but implementing beam shaping to increase scattering) the quality of the illumination within the aquarium is maintained.

[0032] Figure 3 shows an LED provided over a base layer, such as a printed circuit board, with no beam shaping. The LED appears as a point light source, and emits light over a wide angle range, for example 80 degrees

each side of the normal.

[0033] The disclosure provides a set of such lighting elements, and with a beam shaping element associated with each lighting element.

[0034] The beam shaping element is for passing first light which is emitted from the lighting element at an angle to the normal below a threshold and for processing second light which is emitted from the lighting element at an angle to the normal above the threshold, the processing resulting in a greater amount of scattering compared to the passed first light.

[0035] The beam shaping element is an optical element which may for example surround or partially surround its associated lighting element. The threshold angle functions as a cut off angle for the light which has been passed, but light beyond the cut off angle is also emitted, but after some light redistribution. Thus, most of the light with angles smaller than the cut off angle is allowed to pass without scattering, or with much less scattering than the steeper processed light.

[0036] Figures 4 to 7 show examples of different beam shaping elements for an individual LED.

[0037] In all cases, the beam shaping element will be designed taking into account the shape of the lighting element. For example for point like sources such as an individual LED, or for a cluster of LEDs, the beam shaping element is a rotationally symmetric element disposed around the LED or LED cluster. For a linear source, such as a line of closely spaced LEDs, the beam shaping element may also be linear. In this case, the beam shaping element may comprise a strip on each lateral side of the linear light source. The cut off angle is then only needed in the lateral direction (perpendicular to the line direction). For other distributions of light sources, the geometry of the beam shaping element is designed to match the distributions of light sources. For example for a circle or polygonal shape of light sources, the beam shaping element has a corresponding shape.

[0038] Figure 4 shows a first example, which does not form part of the invention, in which a white reflector 40 is placed around the associated LED (or along the edge of a line of LEDs). The direct view to the LED is blocked beyond a certain angle, and this light is redistributed by diffuse (scattering) reflection. Figure 4 shows the beam shaping element with a tapered sides, which widens outwardly with increasing distance from the LED 30. The tapered sides can be used to redirect much of the light at steep angles to be directed in a more downward direction, although the scattering means that some light will still be emitted at large angles to the normal. Alternatively, the scattering reflector 50 may have a stepped side wall as shown in the second example of Figure 5, which does not form part of the invention.

[0039] In this case, the steep angle light is subjected to scattering, but not additionally steered towards a normal downward direction as in the example of Figure 4.

[0040] Figure 6 shows a third example, according to the first alternative of the invention, in which the direct

view of the LED 30 is blocked by using a clear cover plate 60 with a patterned scattering element 62 (which may be on the LED side of the cover plate or on the opposite side). The pattern defines an opening aligned with the LED. For light with angles smaller than the cut off angle, the plate is clear (or only very lightly scattering) at the opening while at larger angles, further away from the LED, the scattering is stronger. The transition between the low and high amounts of scattering is preferably soft to avoid sharp cut off effects.

[0041] The scattering element may be reflective and/or transmissive, and may be achieved by a coating, for example using paint dots with varying density or size, a surface treatment for example surface roughness, or a variation of scattering particle density within the bulk of the material.

[0042] Figure 7 shows a fourth example, according to the second alternative of the invention, in which the cut off is created by a patterned light guiding element 70. The light guiding element has an opening aligned with the LED, so that steep light can enter the light guide at a side face (which is in the normal direction). Above the cut off angle, light enters this side face and is then captured by the light guide 70. It is subsequently coupled out from the light guide by a scattering element or surface. The scattering element may again be reflecting or transmitting, at any side of the light guide, and it may have a varying scattering strength depending on the position. The pattern of the light guide may for example be a scattering surface pattern applied to the outer surface at the bottom of the light guide 70.

[0043] The angle threshold between the zero or low scattering and the higher scattering is for example in the range 45 to 63 degrees, more preferably in the range 55 to 63 degrees, and even more preferably in the range 55 to 60 degrees.

[0044] In all examples above, the first light is passed with no optical processing at all. However, the beam shaping element may instead comprise a scattering element for scattering the first (directional) light, with a smaller amount of scattering than the processing of the second light. This may comprise a lightly scattering diffusing plate mounted over the side walls (Figure 4 and 5), or a portion of reduced scattering in the window (Figure 6) or a lightly scattering diffusing plate mounted over the light guide (Figure 7).

[0045] The lighting scattering diffusing plate may be clear outside the central window, or else a uniform lighting scattering plate may cover the entire lighting arrangement. In this case, there are two scattering mechanisms in series for the large angle light, but only the single scattering element for the small angle, central, light. This central light thus remains more directional than the larger angle light. The scattering of the first light reduces the effect of caustic patterns inside the aquarium by reducing the directionality of the light entering the aquarium.

[0046] As mentioned above, the lighting elements may be formed individually or in groups.

[0047] Figure 8 shows an array of LEDs formed over a two dimensional printed circuit board 32, and each LED having a surrounding beam shaping element 80. Figure 9 shows an array of LEDs formed over a two dimensional area, and the LEDs formed in lines. Each line has a beam shaping element 90 to each lateral side.

[0048] A number of different beam shaping elements have been described above. A lighting system may combine different types of beam shaping element into one product.

[0049] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. An aquarium lighting system comprising:

a base layer (32);
a set of lighting elements (30) mounted on the base layer;
a beam shaping element (60,70,80,90) associated with each lighting element, wherein the beam shaping element is for passing first light which is emitted from the lighting element (30) at an angle to the normal below a threshold and for processing second light which is emitted from the lighting element at an angle to the normal above the threshold, the processing resulting in a greater amount of scattering of the second light compared to the passed first light,
wherein the beam shaping element comprises a plate (60) having a patterned diffuser (62), with an opening in the diffuser pattern for passing the first light, or
wherein the beam shaping element comprises a patterned light guide (70) having an opening in the light guide for passing the first light, the patterned light guide being arranged to capture the second light into the light guide at a side face of the light guide and subsequently reemit the second light from the light guide by means of a scattering element or surface.

2. A system as claimed in claim 1, wherein the base layer (32) comprises a printed circuit board.

3. A system as claimed in claim 1 or 2, wherein the

lighting elements (30) each comprise an LED.

4. A system as claimed in any preceding claim, wherein the lighting elements are arranged in a geometric distribution on the base layer and wherein the beam shaping element is designed to match the geometric distributions of lighting elements on the base layer. 5
5. A system as claimed in claim 4, wherein the geometric distribution of lighting elements in the base layer is linear, circular or polygonal. 10
6. A system as claimed in any preceding claim, wherein the threshold is in the range 45 to 63 degrees, more preferably in the range 55 to 63 degrees and even more preferably in the range 55 to 60 degrees. 15
7. A system as claimed in any preceding claim, wherein the beam shaping element further comprises a scattering element for scattering said first light, with a smaller amount of scattering than the scattering provided by the processing of the second light. 20
8. An aquarium comprising a water container (20) and a lighting system (22) as claimed in any preceding claim for suspension over the water container. 25
9. A aquarium as claimed in claim 8, wherein in use the lighting system (22) is positioned 10 to 30 cm above the water surface. 30
10. A method of lighting an aquarium, comprising:

providing a light output from a set of lighting elements mounted above the water of the aquarium; 35

passing first light which is emitted from the lighting elements at an angle to the normal below a threshold; and

processing second light which is emitted from the lighting elements at an angle to the normal above the threshold by means of a plate (60) having a patterned diffuser (62), with an opening in the diffuser pattern for passing the first light, or by means of a patterned light guide (70) having an opening in the light guide for passing the first light, the patterned light guide capturing the second light into the light guide at a side face of the light guide and subsequently reemitting the second light from the light guide by means of a scattering element or surface, the processing resulting in a greater amount of scattering compared to the passed first light. 40 45 50
11. A method as claimed in claim 10, wherein the threshold is in the range 45 to 63 degrees, more preferably in the range 55 to 63 degrees, even more preferably in the range 55 to 60 degrees. 55

Patentansprüche

1. Aquariumbeleuchtungssystem, umfassend:

- eine Basisschicht (32);

- einen Satz von Beleuchtungselementen (30), der auf der Basisschicht montiert ist;

- ein Strahlformungselement (60,70,80,90), das jedem Beleuchtungselement zugeordnet ist, wobei das Strahlformungselement dazu dient, erstes Licht, das von dem Beleuchtungselement (30) in einem Winkel zu der Normale unter einem Schwellenwert ausgestrahlt wird, weiterzuleiten und zweites Licht, das von dem Beleuchtungselement in einem Winkel zu der Normale über dem Schwellenwert ausgestrahlt wird, zu verarbeiten, wobei die Verarbeitung in einem größeren Ausmaß an Streuung des zweiten Lichts verglichen mit dem weitergeleiteten ersten Licht resultiert,

- wobei das Strahlformungselement eine Platte (60) mit einem strukturierten Diffusor (62) mit einer Öffnung in der Diffusorstruktur zum Weiterleiten des ersten Lichts umfasst, oder

- wobei das Strahlformungselement einen strukturierten Lichtleiter (70) mit einer Öffnung in dem Lichtleiter zum Weiterleiten des ersten Lichts umfasst, wobei der strukturierte Lichtleiter angeordnet ist, das zweite Licht in den Lichtleiter an einer Seitenfläche des Lichtleiters einzufangen und anschließend das zweite Licht von dem Lichtleiter durch ein Streuelement oder eine Streufläche wieder auszugeben.
2. System nach Anspruch 1, wobei die Basisschicht (32) eine Leiterplatte umfasst.
3. System nach Anspruch 1 oder 2, wobei die Beleuchtungselemente (30) jeweils eine LED umfassen.
4. System nach einem vorstehenden Anspruch, wobei die Beleuchtungselemente in einer geometrischen Verteilung auf der Basisschicht angeordnet sind und wobei das Strahlformungselement gestaltet ist, die geometrischen Verteilungen von Beleuchtungselementen auf der Basisschicht abzustimmen.
5. System nach Anspruch 4, wobei die geometrische Verteilung von Beleuchtungselementen in der Basisschicht linear, kreisförmig oder polygonal ist.
6. System nach einem vorstehenden Anspruch, wobei der Schwellenwert im Bereich von 45 bis 63 Grad, bevorzugter im Bereich von 55 bis 63 Grad und noch bevorzugter im Bereich von 55 bis 60 Grad ist.
7. System nach einem vorstehenden Anspruch, wobei das Strahlformungselement weiter ein Streuelement

zum Streuen des ersten Lichts umfasst, mit einem geringeren Ausmaß an Streuung als die Streuung, die durch die Verarbeitung des zweiten Lichts bereitgestellt wird.

8. Aquarium, das einen Wasserbehälter (20) und ein Beleuchtungssystem (22) nach einem vorstehenden Anspruch, das über dem Wasserbehälter hängt, umfasst.

9. Aquarium nach Anspruch 8, wobei das Beleuchtungssystem (22) in Verwendung 10 bis 30 cm über der Wasseroberfläche positioniert ist.

10. Verfahren zum Beleuchten eines Aquariums, umfassend:

- Bereitstellen eines Lichtausgangs aus einem Satz von Beleuchtungselementen, der über dem Wasser des Aquariums montiert ist;
- Durchleiten von erstem Licht, das von Beleuchtungselementen in einem Winkel zu der Normale unter einem Schwellenwert ausgestrahlt wird; und
- Verarbeiten von zweitem Licht, das von den Beleuchtungselementen in einem Winkel zu der Normale über dem Schwellenwert ausgestrahlt wird, durch eine Platte (60) mit einem strukturierten Diffusor (62) mit einer Öffnung in der Diffusorstruktur zum Weiterleiten des ersten Lichts, oder durch einen strukturierten Lichtleiter (70) mit einer Öffnung in dem Lichtleiter zum Weiterleiten des ersten Lichts, wobei der strukturierte Lichtleiter das zweite Licht in den Lichtleiter an einer Seitenfläche des Lichtleiters einfängt und anschließend das zweite Licht wieder von dem Lichtleiter durch ein Streuelement oder eine Streufläche ausgibt,
- wobei die Verarbeitung in einem größeren Ausmaß an Streuung verglichen mit dem weitergeleiteten ersten Licht resultiert.

11. Verfahren nach Anspruch 10, wobei der Schwellenwert im Bereich von 45 bis 63 Grad, bevorzugter im Bereich von 55 bis 63 Grad, noch bevorzugter im Bereich von 55 bis 60 Grad ist.

Revendications

1. Système d'éclairage d'aquarium comprenant :

- une couche de base (32) ;
- un ensemble d'éléments d'éclairage (30) montés sur la couche de base ;
- un élément de mise en forme de faisceau (60,70,80,90) associé à chaque élément d'éclairage, dans lequel l'élément de mise en forme de

faisceau est destiné au passage d'une première lumière qui est émise à partir de l'élément d'éclairage (30) au niveau d'un angle de la normale en dessous d'un seuil et destiné au traitement de la seconde lumière qui est émise à partir de l'élément d'éclairage au niveau d'un angle de la normale au-dessus du seuil, le traitement résultant en une plus grande quantité de diffusion de la seconde lumière par comparaison avec la première lumière passée, dans lequel l'élément de mise en forme de faisceau comprend une plaque (60) présentant un diffuseur à motifs (62), avec une ouverture dans le motif de diffuseur pour faire passer la première lumière, ou dans lequel l'élément de mise en forme de faisceau comprend un guide de lumière à motifs (70) présentant une ouverture dans le guide de lumière pour faire passer la première lumière, le guide de lumière à motifs étant agencé pour capturer la seconde lumière à l'intérieur du guide de lumière au niveau d'une face latérale du guide de lumière et réémettre ensuite la seconde lumière à partir du guide de lumière au moyen d'un élément ou d'une surface de diffusion.

2. Système selon la revendication 1, dans lequel la couche de base (32) comprend une carte de circuit imprimé.

3. Système selon la revendication 1 ou 2, dans lequel les éléments d'éclairage (30) comprennent chacun une DEL.

4. Système selon une quelconque revendication précédente, dans lequel les éléments d'éclairage sont agencés en une distribution géométrique sur la couche de base et dans lequel l'élément de mise en forme de faisceau est conçu pour correspondre aux distributions géométriques des éléments d'éclairage sur la couche de base.

5. Système selon la revendication 4, dans lequel la distribution géométrique des éléments d'éclairage dans la couche de base est linéaire, circulaire ou polygonale.

6. Système selon une quelconque revendication précédente, dans lequel le seuil est dans la plage de 45 à 63 degrés, plus préférentiellement dans la plage de 55 à 63 degrés et encore plus préférentiellement dans la plage de 55 à 60 degrés.

7. Système selon une quelconque revendication précédente, dans lequel l'élément de mise en forme de faisceau comprend en outre un élément de diffusion pour diffuser ladite première lumière, avec une quantité de diffusion plus faible que la diffusion fournie

par le traitement de la seconde lumière.

8. Aquarium comprenant un conteneur d'eau (20) et un système d'éclairage (22) selon une quelconque revendication précédente pour une suspension sur le conteneur d'eau. 5

9. Aquarium selon la revendication 8, dans lequel, lors de l'utilisation, le système d'éclairage (22) est positionné de 10 à 30 cm au-dessus de la surface d'eau. 10

10. Procédé d'éclairage d'un aquarium comprenant les étapes consistant à :

fournir une sortie de lumière à partir d'un ensemble d'éléments d'éclairage montés au-dessus de l'eau de l'aquarium ; 15

faire passer une première lumière qui est émise à partir des éléments d'éclairage au niveau d'un angle vers la normale en dessous d'un seuil ; et 20

traiter une seconde lumière qui est émise à partir des éléments d'éclairage au niveau d'un angle vers la normale au-dessus du seuil au moyen d'une plaque (60) présentant un diffuseur à motifs (62), avec une ouverture dans le motif de diffuseur pour faire passer la première lumière, 25

ou au moyen d'un guide de lumière à motifs (70) présentant une ouverture dans le guide de lumière pour faire passer la première lumière, le guide de lumière à motifs capturant la seconde 30

lumière à l'intérieur du guide de lumière au niveau d'une face latérale du guide de lumière et réémettant ensuite la seconde lumière à partir du guide de lumière au moyen d'un élément ou d'une surface de diffusion, le traitement résultant en une plus grande quantité de diffusion par comparaison avec la première lumière passée. 35

11. Procédé selon la revendication 10, dans lequel le seuil est dans la plage de 45 à 63 degrés, plus préférentiellement dans la plage de 55 à 63 degrés, encore plus préférentiellement dans la plage de 55 à 60 degrés. 40

45

50

55

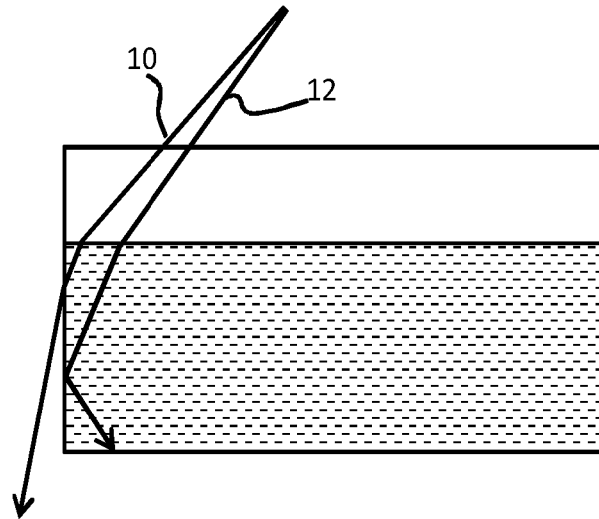


FIG. 1

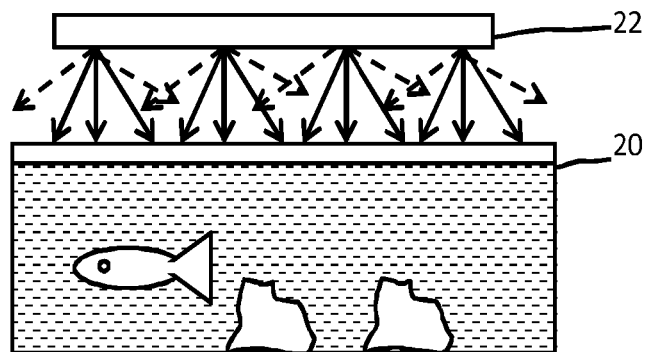


FIG. 2

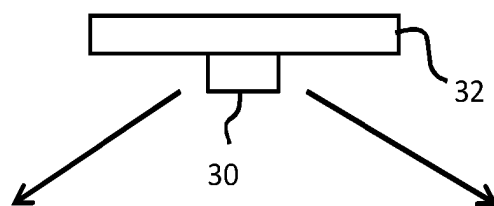


FIG. 3

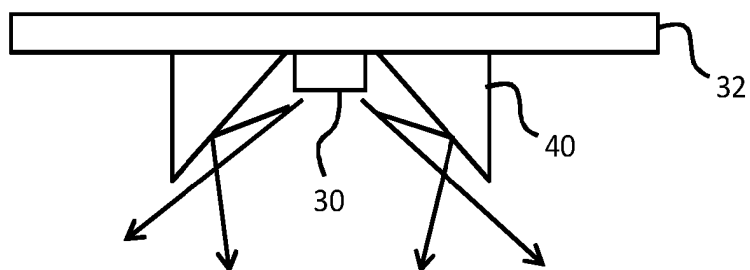


FIG. 4

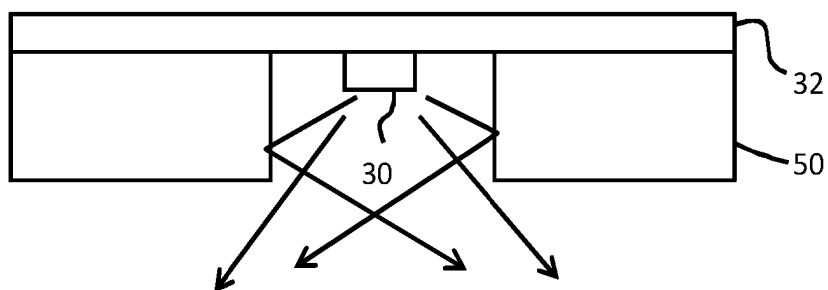


FIG. 5

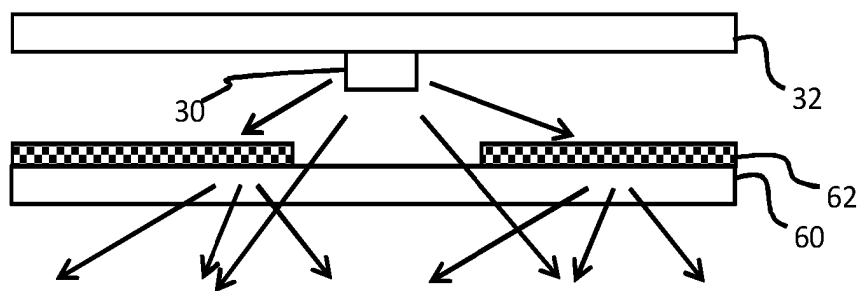


FIG. 6

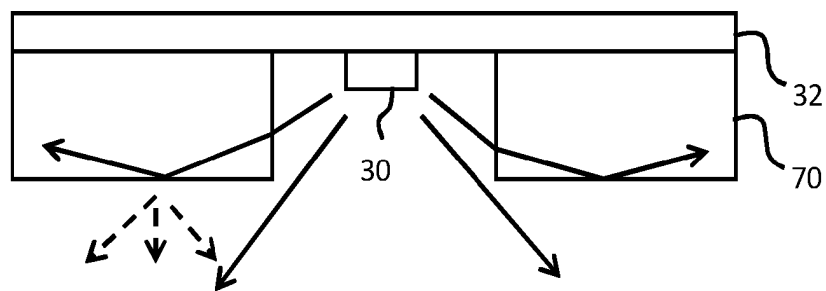


FIG. 7

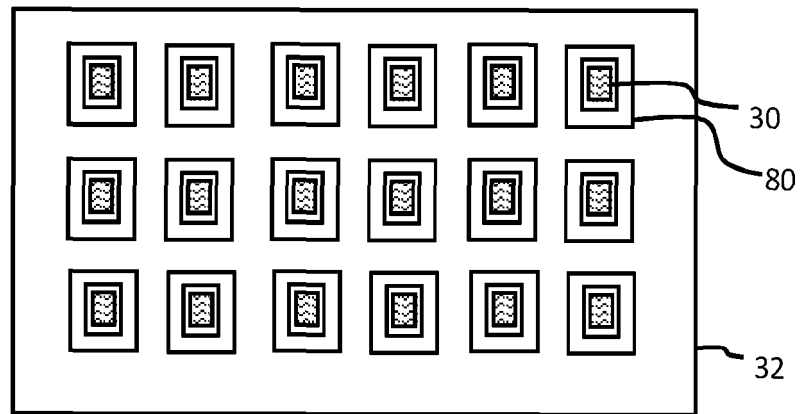


FIG. 8

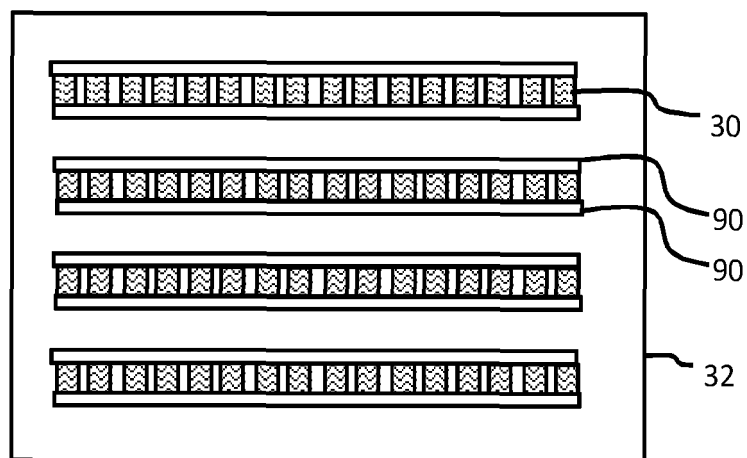


FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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